

25

FISH & RICHARDSON P.C.

Frederick P. Fish
1855-1930

W.K. Richardson
1859-1951

601 Thirteenth Street N.W.
Washington, DC 20005

Telephone
202 783-5070

Facsimile
202 783-2331

Web Site
www.fr.com

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February 29, 2000

Magalie Roman Salas
Secretary
Federal Communications Commission
The Portals TW-A325
445 12th Street, S.W.
Washington, D.C. 20554

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FEDERAL COMMUNICATIONS COMMISSION
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Re: 1998 Biennial Regulatory Review – Amendment of Part 18 of the
Commission's Rules to Update Regulations for RF Lighting Devices
ET Docket No. 98-42
Our Ref.: 07330-008001

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Dear Ms. Salas:

Enclosed please find a Petition for Further Rulemaking in ET Docket No. 98-42,
submitted on behalf of Fusion Lighting.

Very truly yours,


Terry G. Mahn

/sas
Enclosure

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Federal Communications Commission
445-12th Street, S.W.
Room 8-B201
Washington, DC 20554

Mr. Ari Fitzgerald
Office of Chairman Kennard
Federal Communications Commission
445-12th Street, S.W.
Room 8-B201
Washington, DC 20554

Commissioner Susan Ness
Federal Communications Commission
445-12th Street, S.W.
Room 8-B115
Washington, DC 20554

Mr. Daniel Conners
Office of Commissioner Ness
Federal Communications Commission
445-12th Street, S.W.
Room 8-B115
Washington, DC 20554

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Federal Communications Commission
445-12th Street, S.W.
Room 8-A302
Washington, DC 20554

Mr. Paul Misener
Office of Commissioner Furchgott-Roth
Federal Communications Commission
445-12th Street, S.W.
Room 8-A302
Washington, DC 20554

Page 2

Commissioner Michael K. Powell
Federal Communications Commission
445-12th Street, S.W.
Room 8-A204
Washington, DC 20554

Mr. Peter Tenhula
Office of Commissioner Powell
Federal Communications Commission
445-12th Street, S.W.
Room 8-A204
Washington, DC 20554

Commissioner Gloria Tristani
Federal Communications Commission
445-12th Street, S.W.
Room 8-C301
Washington, DC 20554

Ms. Karen Gulick
Office of Commissioner Tristani
Federal Communications Commission
445-12th Street, S.W.
Room 8-C301
Washington, DC 20554

Mr. Julius P. Knapp
Chief, Policy and Rules Division
Office of Engineering and Technology
Federal Communications Commission
445 12th Street, S.W.
Room 7-B133
Washington, DC 20554

Ms. Karen Rackley
Chief, Technical Rules Branch
Office of Engineering & Technology
Federal Communications Commission
445 12th Street, S.W.
Room 7-A161
Washington, DC 20554

Page 3

Mr. John A. Reed
Senior Engineer, Technical Rules Branch
Office of Engineering & Technology
Federal Communications Commission
445 12th Street, S.W.
Room 7-A140
Washington, DC 20554

David C. Jatlow, Esq.
Young & Jatlow
1150 Connecticut Avenue, NW
Suite 420
Washington, DC 20036

Larry Solomon, Esq.
Shook, Hardy & Bacon L.L.P.
Hamilton Square
600 14th Street, NW
Suite 800
Washington, DC 20005-2004

Mitchell Lazarus, Esq.
Fletcher Heald & Hildreth, P.L.C.
1300 North 17th Street
11th Floor
Rosslyn, VA 22209-3801

Ellen Ranard, Esq.
Fusion Lighting, Inc.
7524 Standish Place
Rockville, MD 20855

Daniel Tessler, Chairman
Fusion Lighting, Inc.
7524 Standish Place
Rockville, MD 20855

**Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554**

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In the Matter of)	
)	
1998 Biennial Regulatory Review - Amendment of Part 18)	
of the Commission's Rules to Update Regulations for)	ET Docket No. 98-42
RF Lighting Devices)	
)	
)	

To: The Commission

PETITION FOR FURTHER RULEMAKING

Fusion Lighting, Inc.
7524 Standish Place
Rockville, MD 20855

Terry G. Mahn, Esq.
Ruffin B. Cordell, Esq.
Fish & Richardson P.C.
601 13th Street, N.W.
Suite 901 South
Washington, DC 20005

SUMMARY OF PETITION

Fusion Lighting, Inc. (“Fusion”) seeks a further rulemaking in Docket 98-42 to resolve the impending spectrum conflicts among users of unlicensed spread spectrum (Part 15) devices and RF lighting in the 2.45 GHz ISM band.

Under the current Part 15 Rules, unlicensed devices operating in the 2.45 GHz ISM band must accept interference from ISM devices including RF lighting products. Despite this requirement, Part 15 devices manufactures (“Part 15 Interests”) have pressed the Commission to establish in-band limits for RF lighting. Testing and analyses conducted by the Part 15 Interests and Fusion over the past year have produced undisputed evidence that 2.45 GHz spread spectrum devices and RF Lighting are incompatible. Both technologies are designed to function in the similar environments and even at the same locations (*e.g.*, utility poles), yet cannot exist within hundreds of meters of each other without creating unacceptable interference problems for the public. Because informal efforts by the Commission’s staff to resolve this conflict have failed to bear fruit, these matters must be decided by the Commission and not the consuming public.

Under the 1934 Communications Act, authority to regulate the electromagnetic spectrum in the public interest lies solely with the Commission. Two recent examples involving the Location Monitoring Service (LMS) and the Digital Television Service (DTV) illustrate how the Commission’s spectrum management obligations are being fulfilled in the context of interference to unlicensed devices. In neither docket has the Commission been willing to allow the marketplace to determine which is the “more valuable” of incompatible spectrum technologies.

Relevant case law also requires that the Commission take action where a “significant factual predicate” underlying an existing rule had been removed. Here, the rules for 2.45 GHz unlicensed spread spectrum devices failed to contemplate the development of ubiquitous RF lighting in the ISM band. To fulfill its statutory mandate of managing the electromagnetic spectrum in the public interest, the Commission must alter its regulatory policies on 2.45 GHz spread spectrum devices. Imposing limits or other in-band restrictions on RF lighting would be in violation of International Telecommunications Union (ITU) accords, which the Commission has recognized have the force of law. Such action would

contravene our nation's treaty obligations and move the U.S. out of harmony with all other ITU members by deviating from the international ISM accords.

The 2.45 GHz ISM band was allocated and harmonized by the ITU in 1947. Subsequent World Administration Radio Conferences (WARC) adopted additional ISM bands and, in 1979, the WARC initiated an investigation into the feasibility of setting limits in these bands for the benefit of radio services. Following a 14 year study, the ITU's standing committee on radio interference formally recommended against setting any in-band limits on ISM.

Immediate regulatory action in this docket is needed. Fusion urges the Commission to amend the Part 15 rules to increase the signal rejection capabilities of spread spectrum devices or as an alternative, "migrate" the more susceptible spread spectrum devices out of the 2.45 GHz ISM band and into other less hostile portions of the spectrum. The public will not be without numerous alternatives to the 2.45 GHz wireless offerings being contemplated by the Part 15 Interests.

Finally, it is noted that the Public Notice for this Rulemaking never raised the issue of in-band limits on ISM for the protection of Part 15 devices and it cannot seriously be alleged that such is a "logical outgrowth" of the original proposals. The Administrative Procedures Act requires that the Commission institute a further notice of rulemaking to allow an opportunity for further public comment on these issues.

**Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554**

In the Matter of)

1998 Biennial Regulatory Review - Amendment of Part 18)
of the Commission's Rules to Update Regulations for)
RF Lighting Devices)

ET Docket No. 98-42

To: The Commission

PETITION FOR FURTHER RULEMAKING

Fusion Lighting, Inc. ("Fusion"), by its counsel, hereby submits this Petition for Further Rulemaking ("Petition") in the above-captioned proceeding.¹

In recent months, the Commission has been apprised of two novel technologies that are on a spectrum collision course. Undisputed factual evidence presented to the Commission *ex parte* in this proceeding demonstrates that unavoidable and pervasive spectrum conflicts will occur among users of unlicensed spread spectrum (Part 15) devices and RF lighting in the 2.45 GHz ISM band. Without immediate regulatory intervention, unsuspecting consumers soon will be purchasing and installing RF products that are spectrally incompatible in domestic, commercial and industrial environments. Moreover, Fusion, despite having superior legal rights to the spectrum, will suffer irreparable harm as lighting markets become foreclosed to customers who are induced to invest in unlicensed systems that cannot coexist with RF lighting.

This situation is intolerable for the public as well as for Fusion. It has been brought about by a combination of well-intentioned, but misguided, Commission spectrum sharing policies and reckless entry into the ISM band by spread spectrum device manufacturers.

¹ *In the matter of 1998 Biennial Regulatory Review-Amendment of Part 18 of the Commission's Rules to Update Regulations for RF Lighting Devices*, Notice of Proposed Rule Making, ET Docket No. 98-42, FCC 98-53, released April 9, 1999 ("NPRM"); *First Report and Order*, ET Docket No. 98-42, FCC 99-135, adopted June 9, 1999.

Because long-standing domestic policies and, more significantly, international treaty obligations preclude the Commission from placing any limits on RF lighting devices operating in ITU-designated ISM bands, the Commission's only recourse for preventing wide-scale interference is to amend its Part 15 rules governing spread spectrum devices. A Further Notice of Rulemaking in this docket is, therefore, requested by Fusion for the purpose of developing signal rejection standards for spread spectrum devices operating in the 2.45 GHz ISM band that will render them immune to RF lighting emissions; alternatively, Fusion requests the Commission to take immediate steps to facilitate the migration of unlicensed devices which cannot co-exist with RF lighting to less hostile spectrum locations.

INTRODUCTION

In one sense, this docket had its genesis twenty-five years ago when Fusion engineers first approached the Commission's staff to discuss their plans for developing microwave lighting products. The 2.45 GHz ISM band was identified by the staff as the ideal location for lighting because it was an internationally harmonized band, allowed unlimited ISM emissions and contained very few radio services. Thereupon, Fusion developed its lighting technologies based on the low cost 2.45 GHz magnetron used in millions of microwave ovens throughout the world and, in recent months, succeeded in developing one of the most revolutionary lighting technologies of the century.²

During the developmental period of the Fusion lamp, spread spectrum device manufacturers pressed the Commission for rules to allow entry of their devices into the 2.45 GHz ISM band at power levels significantly higher than previously allowed for unlicensed use. Concerned that these devices would not be able to tolerate interference from high power ISM equipment in the band, the Commission did two very important things: it explicitly warned manufacturers that Commission rules would not protect unlicensed users against ISM interference; and it adopted technical standards for spread spectrum devices which it believed would provide adequate signal rejection capability so as to withstand ISM interference in the band.³

² The U.S. Department of Energy supported Fusion in its efforts with public grants for research and development.

³ See Comments of Fusion Lighting, Docket 98-42.

Still, concerns over spectrum interference continued to surface. The National Telecommunications and Information Administration (NTIA) of the Department of Commerce, for example, warned the Commission, long before it was widely understood that spread spectrum devices were being designed for ubiquitous city-wide communication systems, of the impending spectrum conflict "between Part 15 and RF lighting."⁴ The Commission's response was that it would be "premature" to develop regulations because RF lighting was still in the "early stages of development",⁵ but it subsequently requested a sample RF lamp for testing with Part 15 devices.⁶ Fusion also warned the Commission of these problems in 1996 when the spread spectrum rules were being amended to increase power levels and operating ranges.⁷ Matters came to a head in this NPRM when several Part 15 manufacturers and satellite interests⁸ filed comments requesting in-band limits on RF lighting. Fusion vigorously opposed these proposals on legal, equitable and policy grounds.⁹ Following the formal comment period, the Part 15 Interests began a series of oral and written *ex parte* presentations to the Commissioners' staffs and other agency personnel, describing the potentially destructive interference to their products from RF lighting.

At the urging of the Office of Chief Engineer, Fusion and the Part 15 Interests began a dialog in an effort to determine whether common ground on in-band emissions could be found. Various technical personnel, EMC consultants, the IEEE LAN/MAN standards committee and the Commissioner's own engineering staff studied the matter carefully for over a year. Dozens of *ex parte* comments were filed, many of which contained data and analyses on the interference properties of magnetron emissions used in microwave ovens and Fusion lamps. In the end, no agreement could be reached. Both sides are now predicting that many types of spread spectrum devices will be unable to operate optimally,

⁴ See letter of April 12, 1995, to Richard Smith, OET Chief, from Richard Parlow, Associate Administrator, NTIA, Department of Commerce.

⁵ See letter of May 4, 1995, to Richard Parlow, from Richard Smith.

⁶ See letter of March 7, 1996 from Art Wall to Fusion Lighting.

⁷ See Comments of Fusion Lighting, Docket 96-8, p. 1-3.

⁸ The Part 15 manufacturers involved in this proceeding include the "Bluetooth Promoters" (Ericsson Inc., IBM, INTEL, Nokia and Toshiba), Harris Corp., Metricom, Inc., Symbol Technologies Inc., and 3Com Corporation (collectively, the "Part 15 Interests"). The satellite interests include AirTouch Communications and Globalstar L.P. ("MSS Interests"). Also filing *ex parte* comments is the IEEE 802 LAN/MAN Standards Committee ("IEEE").

⁹ See e.g. Reply Comments of Fusion Lighting, Docket 98-42, August 24, 1998.

or even reliably, in the vicinity of RF lighting installations.¹⁰ RF lamps, despite having legal spectrum priority, will be unable to penetrate markets and environments where spread spectrum systems are installed without causing severe disruption to these operations. In addition, RF lighting customers will be pressured to discontinue their use which prospective customers will be dissuaded from investing in Fusion's revolutionary lighting products because of their propensity to interfere with ISM band communications. This petition, therefore, seeks a resolution of these critical spectrum issues.

I. Undisputed Factual Evidence Presented by the Part 15 Interests and Fusion Lighting Demonstrates that 2.45 GHz Spread Spectrum Devices and RF Lighting are Incompatible in all Environments.

In May 1998, Metricom commissioned EMC testing on the interference properties of microwave ovens and their potential impact on FHSS devices¹¹ on the theory that "the bit error rate and patterns produced by microwave ovens ... will be similar to RF microwave lighting because both use the same magnetron." From that analysis, Metricom's EMC consultant concluded that a magnetron "causes significant harmful interference when it is pulsing and causes a significant excess in burst errors of over 100 bits in length."¹² At about the same time, Metricom performed its own analysis on a Fusion RF lighting installation, concluding that "the duty cycle and location of RF lighting devices are many times more likely to cause interference to Part 15 operations in the 2400 MHz band than microwave ovens."¹³ Because Metricom's FHSS transceivers and Fusion's RF lamps are targeted to occupy many of the same physical locations (*i.e.*, public utility poles and towers), Fusion does not dispute any of these findings.

On November 19, 1998, the Bluetooth Promoters submitted a written *ex parte* analysis¹⁴ of the impact of utility pole-mounted RF lighting on mobile FHSS devices (*i.e.*,

¹⁰ As explained in Section V, analyses of frequency hopping spread spectrum (FHSS) systems have found these to be much more susceptible to RF lighting interference than direct sequence spread spectrum (DSSS) systems.

¹¹ Microwave Interference Report, May 8, 1998, prepared by Bob Friday.

¹² *Id.*

¹³ See Comments of Metricom, Docket 98-42, July 6, 1998, p. 4.

¹⁴ Letter of November 19, 1998, to M. Salas from D. Jatlow ("Bluetooth Analysis").

hands free cell phone operation). The Bluetooth Analysis, which was characterized as "conservative" and "far from worst case scenario" because it was based on microwave oven data, reported a "limiting interference level" of 308 meters from a simple RF lamp. At closer distances the Bluetooth Analysis concluded that RF lighting would entirely block the front-end and "prevent operations."¹⁵ On November 24, 1998, an *ex parte* presentation was made by the Part 15 Interests to Commissioner Powell's staff, during which RF lighting was again described as being capable of degrading Bluetooth devices at 300 meters.¹⁶ Fusion does not dispute the Bluetooth Analysis or the *ex parte* presentation made to Commissioner Powell.

In December 1998, the Part 15 Interests proffered two different *ex parte* proposals to the Commission in an effort to set in-band emission limits on RF lighting. One proposal was for 3 meter limits (peak) of 1 mV/m indoors and 10 mV/m outdoors.¹⁷ The other was for a 20 mV/m limit (peak) in all environments.¹⁸ The Part 15 Interests characterized the 10 mV/m limit in the first proposal as being "near the top of the range that typical Part 15 systems can tolerate without severe disruption."¹⁹ The 20 mV/m peak level in the second proposal was characterized as being "the highest level that Part 15 communication equipment in the band can tolerate as a practical matter and even then the level will inflict serious levels of interference on wireless LAN receivers."²⁰ Fusion does not dispute any of these assertions.

Following a meeting among the parties on January 14, 1999, the Part 15 Interests provided Fusion with two more studies on microwave oven interference to spread spectrum²¹ devices. One of these, the Zyren IEEE White Paper, analyzed oven interference

¹⁵ *Id.*

¹⁶ Letter of November 24, 1994, to M. Salas from D. Jatlow.

¹⁷ Letter of December 1, 1998, to M. Salas from M. Lazarus ("Initial Proposal").

¹⁸ Letter of December 23, 1998, to M. Salas from M. Lazarus ("First Proposal").

¹⁹ *Id.*

²⁰ Letter of March 2, 1999, to T. Mahn from M. Lazarus, containing alternative proposals for in-band limits on RF lighting ("March 2 Proposals") (emphasis added).

²¹ See letter of October 15, 1999, to M. Salas from T. Mahn, transmitting the January 29, 1999, correspondence from M. Lazarus containing studies prepared by (1) Jonathan Horne and S. Vasudevan, March/April 1997 Modeling and Mitigation of Interference in the 2.45 GHz ISM Band ("Horne Study") and (2) Jim Zyren, May 1998, Effect of

to both FHSS and DSSS systems (based on the IEEE 802.11 standard) and concluded, for reasons that will become evident below, that DSSS is "considerably more robust" than FHSS, and "can operate reliably even in very close proximity to a microwave oven."²² On March 2, 1999, the Part 15 Interests submitted a detailed analysis on the minimum separation requirements between a FHSS device and an RF lamp based on a 20 mV/m proposed limit and the methodology of the Zyren IEEE White Paper.²³ The analysis concluded that an FHSS device transmitting 500 byte packets at 2 Mbps to a receiver 30 meters away requires a minimum separation distance of 70 meters from a single RF lamp for "reliable operations."²⁴ Fusion does not dispute these findings.

On May 19, 1999, Fusion provided the Part 15 Interests with measurement data from a sampling of six RF lighting devices, along with an explanation of how the mean peak emissions from these lamps exceeded the 20 mV/m proposal (on which the 70 meter minimum separations were based) by a factor of over 100.²⁵ Fusion's own calculations showed that a FHSS device "would, on average, need to be kept a half mile or more from the front of a typical lamp to avoid peak RFI levels greater than 20 mV/meter."²⁶ Fusion noted that its calculations did not take into account the effects of multiple lamp installations which are typical with most customers nor the effect of high gain reflectors,²⁷ both of which would increase the interference range of a lamp installation. Fusion's data has not been challenged or disputed by the Part 15 Interests.

On June 21, 1999, the Part 15 Interests submitted a third and final proposal calling for a new set of in-band limits coupled with spectrum segmentation for RF lighting. Significantly, the Third Proposal did not change or modify any of the earlier analyses on the

Microwave Oven Interference on IEEE 802.11 WLAN Reliability ("Zyren IEEE White Paper").

²² Zyren IEEE White Paper, p. 23. The study observed that the reason FHSS systems are more susceptible than DSSS is because FHSS "tries to avoid" interference whereas DSSS "suppresses ISM interference."

²³ See March 2nd Proposals, p. 4. Multipath effects were not considered nor were multiple RF lamps, either of which, it was noted, could increase the minimum separation requirements.

²⁴ The Part 15 Interests define a packet error rate (PER) of less than 10% to be "reliable operations."

²⁵ See Letter of May 19, 1999, to M. Salas from T. Mahn, p. 4 ("Fusion Response to Proposals 1 and 2").

²⁶ *Id.* p. 5.

²⁷ *Id.*

minimum separation requirements for RF lighting but merely indicated a willingness to “live” with the new proposal.²⁸ In response to the Third Proposal, Fusion provided the following summation of the interference problem confronting the Commission:

Both Fusion's and [the Part 15 Interests'] estimates were extremely conservative, and Fusion believes for several reasons that a significant level of interference with Part 15 receivers will occur even at separations of a half-mile or more. Fusion assumed a linear field attenuation at 2.45 GHz and a ten-inch diameter reflector for light pipes, giving forward to backward signal gain of only 6 dB. Reflectors for RF Lighting floodlights and downlights have larger openings and are higher-gain antenna, increasing the required separation from a single RF lamp to 704 meters on average. And finally, Fusion's May estimate assumed only a single lamp per installation in order to be consistent with Part 15/MSS assumptions; multi-lamp installations are the norm, however, and thousands can be concentrated in a large factory, street lighting system, airport, arena or shopping mall. Under these circumstances, whether the current rules or any of the Part 15/MSS proposals are used, the physical separation that would assure non-interference would eliminate any coherent market for at least one and possibly for both of these potentially ubiquitous technologies.²⁹

As the record in this docket presently stands, the parties are in agreement that FHSS (and to a lesser extent DSSS) devices and RF lighting present the Commission with an intractable interference dilemma under the current rules. Both technologies are intended to be used in the same environments and in some cases the exact same location (*e.g.*, utility poles), yet they cannot exist within hundreds of meters of each other without creating unacceptable interference problems for the public.³⁰

²⁸ See letter of June 21, 1999, to M. Salas from M. Lazarus ("Third Proposal"). Prior to this letter all interference studies and analyses were based on peak emissions from microwave ovens (and RF lamps). The Third Proposal, however, was couched in terms of average emissions, a wildly inconsistent position with all earlier proposals. Regardless of how the new limits were characterized, it cannot change the fact that significant interference from RF lighting is projected for FHSS devices.

²⁹ See letter of September 3, 1999, to M. Salas from K. Kipling ("Response to Third Proposal"). Fusion's data appeared to address the MSS concerns raised in the *ex parte* remarks as actual lamp emissions above 2483.5 MHz were shown to be at or below the threshold levels of concern (10 mV/m) to MSS services.

³⁰ All the parties seem also to agree that the current program of Part 15 device labeling and user warnings regarding ISM interference is inadequate to protect the public from this problem.

II. As a Matter of Law and Policy the Commission Must Begin a Rulemaking to Resolve the Spectrum Conflict.

At the Commission's urging, Fusion and the Part 15/MSS Interests spent 10 months searching for common ground. The parties held a face-to-face meeting, exchanged technical data, and performed independent analyses on theoretical models and actual equipment. Ultimately, each side has come to realize that these technologies are fundamentally incompatible, yet each is deeply committed to its current business plans and unlikely to change direction voluntarily.

In its written and verbal submissions, Fusion described how its revolutionary lighting technology evolved from the low cost, highly reliable magnetron that is the backbone of the microwave oven industry. In response to false assertions that its lamps could easily be shielded for "pennies per unit,"³¹ Fusion provided a detailed analysis on how its lamps already shield emissions and how additional shielding would completely destroy lighting efficacy.³² Responding to the Third Proposal requesting ISM band segmentation, Fusion analyzed the cost of redesigning its lamps using custom magnetrons and solid state power supplies to reposition and stabilize lamp emissions, and showed how these changes would drive up the end user cost of its lamps over tenfold, destroying their competitiveness with other conventional lighting products.³³

For their part, the Part 15 Interests admit to not being interested in using other authorized bands for their technology (e.g., the 5.8 GHz band where there are virtually no ISM activities), because of higher component costs and reduced propagation characteristics.³⁴ They also shrug off the fact that their industry has been warned repeatedly

³¹ See letter of November 25, 1999, to M. Salas from M. Lazarus re *ex parte* meeting and presentation by Harris Semiconductor.

³² See letter of August 26, 1999, to M. Salas from T. Mahn. Data provided to the Commission's staff on August 25, 1999, demonstrated that Fusion already shields its lamp for RF at a cost of 20% in lighting efficacy. In order to meet the Part 15 Interests' Third Proposal, lighting efficacy would have to be sacrificed another 28% from current levels, rendering Fusion lamps non-competitive with other high-end lighting technology.

³³ *Id.* Data provided to the Commission's staff during the August 25th meeting charted the price elasticity of lighting based on cost of the magnetron and power supply. A specialty magnetron to accommodate the Third Proposal would cost over 5 times more than the current magnetron (from \$40 to \$228); and the cost of a solid state switching power supply would be 8 times the cost of the current design (from \$150 to \$1,200). Even ignoring the serious issues of component reliability, product lifetime costs, and service costs associated with this novel design, the component cost increases alone would destroy the competitiveness of 2.45 GHz RF lighting.

³⁴ See letter of April 12, 1999, to T. Mahn from M. Lazarus responding to six questions raised by Fusion in its

by the Commission that ISM interference in the 2.45 GHz band could render their products useless unless they are designed with adequate signal rejection properties.³⁵ Instead, they boast openly of how they are planning to move aggressively into the 2.45 GHz ISM band with powerful systems capable of providing citywide services for millions of mobile users.

In hindsight, it is clear that these manufacturers believed microwave ovens would be the only emissions with which they would have to contend. They now see that these were wrong assumptions. And rather than harden their technology against interference, they come before the Commission seeking regulatory relief, warning Fusion and others that if relief is not forthcoming, they will battle it out over the airwaves regardless of how it might impact the public. In their last *ex parte* filing, the Part 15 Interests offered this chilling scenario on how they think the 2.45 GHz spectrum should be managed: "if the two technologies cannot function compatibly, so that users must choose between them, the marketplace will decide which is more valuable."³⁶

A. The Commission, Not the Public, is Required to Resolve Spectrum Conflicts.

Under the 1934 Communications Act, the Commission is given authority to regulate the electromagnetic spectrum in the public interest.³⁷ Such authority, likened to that of a spectrum "traffic cop," has been manifested over the years in a wide variety of allocation

March 12th letter.

³⁵ See, e.g., *In the Matter of Authorization of Spread Spectrum and Other Wideband Emissions*, Gen. Docket No. 81-413, Notice of Proposed Rule Making, 49 Fed. Reg. 21951, ¶ 24, May 1994 (Commission cautioning spread spectrum manufacturers against "heavy interference from [ISM]"); *Id.* First Report & Order, 58 RR2d 251, 256 May 1985 (warning spread spectrum manufacturers that they must accept "any interference which [ISM] may cause to their own operations", and of the "dangers" to communications from ISM emissions); *In the Matter of Revision of Part 15 of the Rules*, Gen. Docket No 87-239, First Report & Order, 54 Fed. Reg. 17710, ¶ 58, April 1989 (warning that "certain consumer devices" might not be suitable for operation in ISM bands); *In the Matter of Amendment of Parts 2 and 15 of the Commission's Rules Regarding Spread Spectrum*, Gen. Docket No. 96-8, First Report & Order, 62 Fed. Reg. 26239, ¶ 14-17, April 1997 (reminding manufacturers that it would be incumbent upon them to design their devices to be capable of rejecting interference from ISM operations).

³⁶ See letter of September 14, 1999, from M. Lazarus to M. Salas, p. 2. During the January 14, 1999, meeting between Fusion and the Part 15 Interests, Fusion was warned that if a technical accommodation were not found, the Part 15 Interests were prepared to let the market decide and that collectively, they could easily overwhelm Fusion's efforts to sell its products.

³⁷ 47 U.S.C. § 151 et seq.

programs, service rules and equipment standards designed to ensure, among other things, that radio interference among spectrum users is minimized. To meet increased spectrum demands, Congress recently expanded the Commission's authority to manage the spectrum for "flexible use," provided such use does not result in harmful interference "among users."³⁸

As spectrum overseer, the Commission performs one of its most important regulatory functions, which is to establish and enforce a legal hierarchy of spectrum usage. Under the current scheme, users of Part 15 devices occupy the lowest tier and have no spectrum rights. They may not cause harmful interference and must accept interference from any other spectrum-using device, including ISM equipment.³⁹ Because Part 15 devices historically have operated at very low power levels over short ranges, interference problems to licensed users have been minimal, specific to individual devices, and limited in time or duration. In recent years, as new programs were implemented to allow unlicensed devices to operate at much higher power levels (*e.g.*, in the tens of watts EIRP), over larger geographic areas (*e.g.*, over tens of miles), and for important public needs (*e.g.*, health care), these devices⁴⁰ have begun receiving interference and their users are complaining.

Historically, unlicensed devices were not entitled to spectrum protection so the Commission never had to deal with interference problems to or among unlicensed devices. Instead, the Commission has relied on regulatory "substitutes" such as voluntary consensus standards⁴¹ and industry-developed spectrum etiquettes.⁴² When these surrogates for regulation fail, and where the threat of interference is widespread or repeated or impacts the health, safety, or welfare of consumers, the Commission is obligated under the law to step in and manage the spectrum conflict. Two recent examples which have similarities to the present dispute, illustrate how the Commission's spectrum management obligations are being fulfilled in the context of interference to unlicensed devices.

³⁸ 47 U.S.C. § 303(g)(2)(c) (emphasis added).

³⁹ 47 C.F.R. § 15.5(b).

⁴⁰ See, *e.g.*, 47 C.F.R. §15.247 (spread spectrum devices); § 15.301 (unlicensed PCS); § 15.401 (UNII devices); § 15.255 (millimeter wave devices).

⁴¹ See, *e.g.*, IEEE 802.11, the standard for 2.45 GHz spread spectrum radio LAN devices.

⁴² See, *e.g.*, *Amendment of Parts 2, 15 and 97 of the Commission's Rules to Permit Use of Radio Frequencies Above 40 GHz*, Third Report & Order, 13 FCC Rcd. 15074, ¶ 11 (1998).

1. Part 15 vs. Location Monitoring Services (LMS)

In the LMS Docket,⁴³ various Part 15 spread spectrum device manufacturers (several of whom are involved in this NPRM) petitioned the Commission for rules that would create a "safe harbor" for their devices in the 915 MHz ISM band against interference complaints from licensed LMS operators. The manufacturers sought protection from higher priority band users despite the fact that they were marketing devices with full knowledge of the potential for interference and on the express condition that such devices "accept any interference received including interference that may cause undesired operation."⁴⁴ Contending, as they do here, that their devices could not coexist with higher powered users,⁴⁵ they pressed the Commission for a limitation on both the power and location of licensed services so that their sensitive receivers would not become "obsolete and unusable" in the band.⁴⁶

Taking note of the extensive device entry in the 915 MHz band and potential harm to the public from LMS interference, the Commission adopted rules providing a Part 15 safe harbor from licensee complaints.⁴⁷ More significantly, however, the Commission conditioned the grant of future LMS licenses on the licensees' ability to demonstrate through actual field tests that their systems would not cause unacceptable levels of interference to Part 15 devices.⁴⁸ In the Commission's view, it was irrelevant that LMS was a licensed service established long before Part 15 entry or that LMS was often used for public safety operations. What was key to its decision-making was that the public interest could not be served by such incompatible uses of the same spectrum.

⁴³ See *Amendment of Part 90 of the Commission's Rules to Adopt Regulations for Automatic Vehicle Monitoring Systems*, Notice of Proposed Rule Making, PR Docket No. 93-61, 8 FCC Rcd. 2502 (1993) ("LMS NPRM"); Report & Order, PR Docket No. 93-61, 11 FCC Rcd. 4695 (1995) ("LMS R&O"); Order on Reconsideration, PR Docket No. 93-61, 11 FCC Rcd. 16905 (1996) ("LMS Reconsideration"). Hereinafter, collectively referred to as the "LMS Proceeding."

⁴⁴ See LMS NPRM ¶ 24; LMS R&O ¶ 35.

⁴⁵ See LMS R&O ¶ 32.

⁴⁶ *Id.*

⁴⁷ See LMS R&O ¶ 36.

⁴⁸ *Id.* ¶ 81-81. The Commission went on to state that it would expect such testing to be accomplished through close cooperation between multi-lateration LMS systems users and operators of Part 15 systems.

2. Part 15 vs. Digital Television Services (DTV)

A similar situation confronts the Commission in the Wireless Medical Telemetry (WMT) Docket.⁴⁹ For years, unlicensed WMT devices had been operating on various television (TV) channels with few interference complaints. Following the passage of legislation in 1996 authorizing DTV, the Commission amended Part 15 to increase the power and number of channels on which WMT devices could operate to improve their immunity to DTV signals. These efforts eventually proved futile when, in 1998, a TV station converting to DTV caused interference to the operation of several WMT devices at a nearby hospital. The Commission and the Food and Drug Administration responded immediately and imposed temporary corrective measures nationwide to ensure that all hospitals would have sufficient opportunity to modify their unlicensed equipment before licensed DTV stations went on the air. In a rulemaking begun this past July, the Commission is proposing to move the unlicensed WMT devices out of the TV bands and into spectrum allocations where they will have priority status.⁵⁰ Once again, however, it was irrelevant that these devices were placed on the market with full knowledge of their secondary status, nor was it relevant that the devices could be re-tuned by the end-user to avoid the DTV interference. What was important was that the Commission observed one class of users being threatened by another, albeit senior class of users, and took affirmative steps to resolve the conflict.⁵¹

In neither the LMS nor the WMT Docket was the Commission willing to turn a blind eye to the problem of interference or rely on the marketplace to decide which of two incompatible technologies is the "more valuable." Inarguably, it would be a dereliction of its affirmative duty to manage the spectrum for the Commission, in the current proceeding,

⁴⁹ See *Amendment of Parts 2 and 15 of the Commission's Rules to Create a Wireless Medical Telemetry Service*, Notice of Proposed Rule Making, ET Docket 99-255, released July 16, 1999 WMT.

⁵⁰ *Id.*

⁵¹ The Commission could have pointed to the long standing rules that put all Part 15 device manufacturers and users on clear notice that these products have no spectrum rights. It also could have admonished the Part 15 manufacturing community for not developing equipment with greater immunity and signal rejection capability, and could have worked to encourage new designs or deployment programs that would minimize or eliminate the interference concerns. In the LMS Proceeding, none of the described Part 15 users involved patient care or public safety and the interference was not a "blanketing" situation like it is with RF lighting. In the Wireless Medical Telemetry Proceeding, the DTV interference involved fixed locations and the WMT devices were tunable, suggesting that interference could have been avoided by routine coordination.

to let the marketplace decide the matter as the Part 15 Interests suggest. Nor would the Commission fulfill its duty by providing a temporary fix, such as providing Part 15 manufacturers with a spectrum “template” around which they can design new products. This non-solution, suggested recently by the Commission's staff, is unworkable for several reasons. First, there can be no assurance that Part 15 manufacturers are willing or able to change their designs to avoid or minimize Fusion’s lamp emissions. Second, even if they could, there can be no assurance that Fusion's lighting designs will not change.⁵² Third, it would be demonstrably unfair to lock Fusion into its current spectrum design when there may be more efficient or economic approaches to 2.45 GHz ISM lighting that have yet to be discovered. Finally, the product designs to which the Part 15 Interests are already substantially committed (and which require hundreds of meters of separation to coexist with Fusion lamps) cannot be modified once they are on the market.⁵³ Any attempt to impose a “design around” solution without addressing the more fundamental interference problem simply off-loads the Commission’s management responsibilities onto the unsuspecting public.

B. RF Lighting Interference Represents a Change in the Significant Factual Predicate Underlying the Spread Spectrum Rules.

Relevant case law compels the Commission to take action in this matter. In Geller v. FCC,⁵⁴ the Commission was ordered to undertake a rulemaking where a “significant factual predicate” underlying an existing rule had been removed. Similarly, in Bechtel v. FCC,⁵⁵ the Commission was ordered to reexamine a policy statement that appeared no longer to be justified based on a change in circumstances. Here, the rules for unlicensed spread spectrum devices, developed in 1985, were predicated on the Commission's express understanding that they could coexist in-band with ISM.⁵⁶ At the time, the only known ISM

⁵² Changes in the geometry of the lamp cavity, source of magnetron supply or RF shielding techniques currently applied to the lamp housing or reflector could significantly shift the RF properties of the lamps.

⁵³ See Electronic News Online, October 5, 1999, “Bluetooth Chips to go from 0 to 260 million in four years.”

⁵⁴ See Geller v. FCC, 610 F.2d 973 (D.C. Cir. 1979); American Home Protection Association v. Lyng, 812 F.2d 1 (D.C. Cir. 1987). Case law holds that where “significant factual predicate” is fundamental to the agency's decision criteria, a material change in that predicate requires a new rulemaking.

⁵⁵ See Bechtel v. FCC, 957 F.2d. 877 (D.C. Cir. 1992).

⁵⁶ To decrease their susceptibility to potential ISM interference, DSSS devices were required to demonstrate a processing gain of 10 dB and FHSS devices were required to adhere to bandwidth, dwell time and minimum hopping

devices were microwave ovens, and RF lighting was not then a foreseeable application. When Fusion and other ISM manufacturers⁵⁷ subsequently warned the Commission of impending spectrum conflicts from RF lighting and sought rules to make Part 15 devices less susceptible to interference, it brushed aside the problem by noting that ISM had spectrum priority. It was not until detailed interference studies were presented in this NPRM that the Commission finally realized what its regulatory policies had engendered and how serious an interference problem the public faced.

Whether such policies were well-intentioned or not is beside the point; what matters is that the underlying factual predicate for these policies -- mutual coexistence between 2.45 GHz spread spectrum and ISM -- no longer exists. In such instances, the courts have uniformly held that the regulatory agency is required to institute a rulemaking to rectify the problem.

III. International Treaty Obligations of the United States Preclude the Adoption of Limits or Other In-Band Restrictions on RF Lighting.

As the foregoing makes clear, the Commission is at a crossroads. To fulfill its statutory mandate of managing the electromagnetic spectrum⁵⁸ in the public interest, it must alter either its regulatory policies on RF lighting or its rules for 2.45 GHz spread spectrum devices. Should the Commission choose to impose limits or other in-band restrictions on RF lighting, it would be in violation of International Telecommunications Union (ITU) regulations, which the Commission has repeatedly stated have the force of law. Moreover, it would contravene our nation's treaty obligations under the U.S. Constitution. Even more significant, it would be the first time in history that any ITU signatory country has taken the step of regulating an ISM technology in-band, moving the U.S. out of harmony with all other ITU members and deviating sharply from recently adopted international ISM standards governing RF lighting in the 2.45 GHz band.⁵⁹

channel requirements, all based on the understanding that low duty cycle microwave ovens would be the only ISM interference in the band.

⁵⁷ See fn 33 *supra*, First Report & Order, Docket 96-8.

⁵⁸ See 47 U.S.C. § 303(g)(2)(c).

⁵⁹ RF lighting in the microwave bands (e.g. 915 MHz, 2.45 GHz and 5.8 GHz) is governed internationally by CISPR Publication 11 which permits unlimited emissions per the ITU treaty. See CISPR 11, Amendment 1 1999-05, Section 1.1. All other lighting is regulated internationally by CISPR Publication 15 which contains limits in the ISM bands.

A. The 2.45 GHz ISM Band is an International Treaty Allocation.

Article VI, Section 2 of the U.S. Constitution states that all Treaties made under the authority of the United States shall be the supreme Law of the Land. Section 303(r) of the Communications Act requires that the Commission may make rules and regulations "not inconsistent with law" that are necessary to carry out "the provisions of this Act, or any international ... treaty, or regulations annexed thereto."⁶⁰

The 2.45 GHz ISM band was allocated and harmonized by the ITU, an international treaty organization to which the United States is a signatory, at the International Radio Conference held in Atlantic City in 1947. This band was given priority usage and unlimited emission rights in Region 2 (a global region which includes the United States) and several other countries. Footnote 220 of the 1947 ITU Table of Allocations, sets forth the rules on this band:

[T]he frequency 2450 Mc/s is designated for [ISM] purposes. Emissions must be confined within the limits of ± 50 Mc/s of that frequency. Radiocommunication services operating within those limits must accept any harmful interference that may be experienced from the operation of [ISM] equipment.⁶¹

Following Congressional ratification of the 1947 treaty,⁶² the Commission allocated the 2.45 GHz band for ISM priority⁶³ in the United States and later added it to its Part 18 Rules.⁶⁴

⁶⁰ 47 U.S.C. § 303(r).

⁶¹ Radio Regulations, Annexed to the International Telecommunications Convention, Recommendations and Resolution adopted by the International Radio Conference, Atlantic City 1947, General Secretariat of the ITU, 1949. (emphasis added).

⁶² See T.I.A.S. 1901, October 2, 1947, United States Statutes at Large 1949, Volume 63, Part 2, Treaties.

⁶³ FCC Docket No. 6651, Order, May 15, 1947.

⁶⁴ *Id.* Order (nunc pro tunc), December 19, 1956. A footnote in the Table for 2.45 GHz ISM band contains language that is virtually identical to the original language in ITU footnote 220 of the 1947 Treaty. See 47 C.F.R. § 2.106 (footnote 752).

The ISM frequency allocations also were the subject of the ITU's 1979 World Administration Radio Conference (WARC), where five new ISM bands were allocated and the earlier band regulations reaffirmed.⁶⁵ Following Congressional ratification of the 1979 WARC, the Commission added the new ISM bands to the U.S. Table of Frequency Allocation in 1983,⁶⁶ expressly acknowledging that final acts of the ITU, once ratified by the United States, have the force of law:

[T]he Final Acts of the 1979 WARC, which comprise an international treaty[,] became effective internationally on January 1, 1982, for administrations that have ratified the treaty. The United States ratified the treaty on September 6, 1983. Therefore, it now has the force of law in the United States and we are obliged to adhere to its provisions.⁶⁷

The Commission went on to state that "[i]n our domestic implementation actions, we must take full account of the international provisions even though in some instances they do not fully agree with those that the United States had proposed."⁶⁸ Regardless of how Commission policies may have evolved since the 1947 and 1979 treaty accords, therefore, the 2.45 GHz band remains a treaty allocation in which ISM may not be encumbered for the benefit of other radio users.

B. ITU Regulation of ISM Preempts Inconsistent National Regulation

In establishing the original ISM bands, the ITU was seeking to promote the use and harmonization of spectrum for non-communications purposes for the benefit of the

⁶⁵ See *Amendment of Part 2 of the Commission's Rules Regarding Implementation of the Final Acts of the World Administrative Radio Conference*, Geneva 1979, Second Report & Order, 55 RR 2d. 1500 (1983). ("WARC-79 Second Report & Order"). In adopting the WARC-79 allocations, the U.S. "reservations" were listed in an Appendix and no mention was made of any of the ISM bands.

⁶⁶ *Id.*

⁶⁷ See "WARC-79 Second Report & Order" ¶ 1.

⁶⁸ WARC-79 Second Report & Order, ¶ 10. An example of the Commission's recognition that international treaties must be followed even when it disagrees involved the 1981 updating of requirements for shipboard radios. There the agency stated that "[s]ince the U.S. agreed in an international convention to abide by these [noise] tolerances, it cannot change its position unilaterally and permit a vessel's call for help to go unheeded." *In the Matter of Amendment of Part 83 of the Rules*, Report & Order, 46 Fed. Reg. 19007 (March 27, 1981).

international public. To achieve these international goals, the ITU expressly exempted ISM devices from in-band emission limits. When the five new bands were added at the 1979 WARC, the ITU noted its concern that ISM applications had grown since 1947 and were now operating on "various frequencies throughout the spectrum."⁶⁹ An increase in the number of bands was agreed to by the ITU, but "only on the condition that limits of radiation from such equipment be specified within the bands newly designated for worldwide use and outside all the bands designated for ISM equipment."⁷⁰

To implement these conditions, the ITU directed the CCIR, its standing committee on radio interference, to work in collaboration with the IEC/CISPR to study the emissions from ISM equipment and specify limits inside the new bands and outside of all ISM bands. Shortly thereafter, CCIR and CISPR formed a joint study group to fulfill this mandate. After 14 years of study, the CCIR/CISPR group recommended, in 1994, that the ITU not adopt any in-band limits for any ISM allocations.⁷¹ In a report issued as a formal ITU Recommendation, the following relevant findings were made regarding the scope and purpose of ISM band regulations⁷²:

- radio services operating in the bands designated for use by ISM equipment prior to WARC-79 [e.g., the 2.45 GHz band] are required to accept harmful interference;
- severe difficulties could arise if different limits were to be recommended by different international bodies for the same class of [ISM] equipment; and
- the setting of restrictive limits will decrease the usefulness of the ISM bands for industrial purposes. The result of this would be to encourage the use of ISM equipment in frequency ranges more suitable to their processes, but detrimental to radio services.⁷³

⁶⁹ ITU Resolution No. 63, WARC-79 Final Acts.

⁷⁰ *Id.*

⁷¹ The results of the study can be found in CISPR Publication 28.

⁷² Recommendation ITU-R SM.1056 Limitation on Radiation for ISM Equipment (1994).

⁷³ *Id.* Preamble f, m and Section 3.1 (emphasis added).

The first finding restates the bedrock principle that all other spectrum users must accept in-band interference from ISM devices. The second finding references the need to protect equipment manufacturers from having to design equipment to meet varying and possibly contradictory national or international requirements. The third finding underscores the perceived global danger that could come from national requirements that drive ISM into frequency bands where radio services will be harmed. In other words, the ITU Recommendation concluded that the original ISM band provisions should be left intact.

Under the ITU Constitution, ISM band allocations are clearly recognized as matters of "concern of [ITU] members in general"⁷⁴ and, therefore, are off limits to national regulation. Differing or conflicting national treatment of ISM bands would undermine the ITU scheme of promoting international usage, harmonizing ISM locations in the spectrum, and protecting international radio communications from potentially harmful ISM emissions. If any changes are warranted in the scheme, they require study and implementation at the international level, as the ITU made abundantly clear in 1979.⁷⁵ The ITU created the original ISM bands, facilitated their expansion in 1979, and initiated the international study on limits -- unquestionably occupying this regulatory field to the exclusion of its member states.

It is hardly surprising, therefore, that the Commission has never challenged the ITU's supremacy with regard to the ISM bands, even when matters of a domestic nature are involved. In preparing for the 1992 WARC, for example, the Commission considered proposing to the ITU a reallocation plan for the 2.45 GHz ISM band to accommodate Digital Audio Radio Services (DARS).⁷⁶ DARS was then a new technology designed for domestic use, yet the Commission considered it necessary to seek ITU consent before attempting any in-band reallocations. Although the Commission eventually decided to drop the matter, it is significant to note that the Commission never considered reallocating the

⁷⁴ See Article 42, § 193 of ITU Constitution.

⁷⁵ Resolution No. 63, ¶ 2.

⁷⁶ *In the Matter of An Inquiry Relating to Preparation for the ITU WARC for dealing with Frequency Allocations in Certain Parts of the Spectrum*, Gen. Docket No. 89-544, Second Notice of Inquiry, 5 FCC Rcd 6046, 6061 ¶¶ 102-03 (1990). Ultimately, the idea was dropped when the Commission became aware that manufacturers and users heavily depended on the entire 2.45 GHz band for ISM operations. See *In the Matter of An Inquiry Relating to Preparation for the ITU WARC for dealing with Frequency Allocations in Certain Parts of the Spectrum*, Gen. Docket No. 89-544, Report, 69 RR2d 484, 494 ¶ 73 (1991).

band or imposing in-band limits to accommodate DARS through a domestic rulemaking, reflecting its correct understanding that such unilateral regulation of ISM was off-limits to ITU-signatory nations.⁷⁷ It is also not surprising then that, in over 50 years since the original ISM bands were allocated by the ITU, no national authority has ever sought to impose in-band limits or reallocation for any ISM device or application for the benefit of radio services.⁷⁸ Under the treaty provisions of the U.S. Constitution, the Commission may not now adopt ISM band regulations that are inconsistent with these ITU accords.⁷⁹

C. The ISM Bands Were Never Envisioned as Accommodating Millions of Unlicensed Communication Devices

When the ISM bands were first allocated by the ITU in 1947, “unlicensed” communication devices did not exist. Spectrum management was still in its relative infancy and radio services that would be using the ISM bands on a secondary basis were clearly understood to be licensed offerings under the strict regulatory control of national authorities. If interference problems between radio and ISM surfaced, national authorities could quickly step in to avert trouble. The ITU drafters never imagined the possibility that an entire ISM band, in virtually every geographic market, could be saturated with unlicensed communications devices beyond the control of the licensing authorities. Such a scenario -- a

⁷⁷ Another instance of the Commission deferring to the ITU involved a recent effort by the Millimeter Wave Communications Working Group to propose in-band limits in the 61.25 GHz ISM band. Although asked to begin a rulemaking, the Commission supported a draft international “study question” that was submitted to US Working Party 1A, the federal government-led group representing U.S. interests before the ITU Radiocommunications sector.

⁷⁸ The ITU resolution was careful to note that limits could not be imposed on ISM for the protection of “radio consumers” only, leaving open the possibility for national governments to adopt health or safety limits on ISM in-band.

⁷⁹ Agency decisions often have been overturned as violative of U.S. treaty obligations. *See, e.g., Caterpillar Tractor Co. v. Commissioner of Patents and Trademarks*, 650 F. Supp. 218, 219 (E.D. Va. 1986) (overturning a U.S. Patent and Trademark Office (PTO) rule interpreting a provision of the Patent Cooperation Treaty, finding that the PTO's rule was in conflict with the “plain meaning” of the treaty and therefore “not in accordance with law” under the Administrative Procedures Act, 5 U.S.C. Section 706(2)(A)); *Saiyed v. Transmediterranean Airways*, 509 F. Supp. 1167, 1169 (W.D. Mich. 1981) (voiding a rule of the Civil Aeronautics Board precluding recovery from an airline for certain types of damages as being in conflict with the Warsaw Convention, which the court described as “a treaty [that] is absolutely controlling in cases involving international transportation”); *Rainbow Navigation Inc. v. Department of the Navy*, 686 F. Supp. at 359-60 (D.D.C. 1988) (subsequent history omitted) (overturning the Navy's efforts to “put Rainbow out of business” by enjoining enforcement of a Navy procurement regulation that otherwise would have denied Rainbow a shipping contract, and finding that the Navy's rule was contrary to the “straightforward and unmistakable” language of the treaty requiring the award of the contract to Rainbow under the relevant bidding rules).

veritable ISM spectrum “free-for-all” – would have flown in the face of the ITU’s original ISM accords.

Because the bands were allocated by treaty for the benefit of ISM, as opposed to radio communications, it has been incumbent on every ITU signatory country to ensure that these treaty goals are realized. This means that while the ISM bands can be used on a secondary basis for “radio services” they are not to be manipulated or dominated by powerful radio interests to the detriment of ISM applications. Overwhelming an ISM band with unlicensed devices so it becomes politically and commercially infeasible for emerging ISM applications to obtain a foothold in their own spectrum completely vitiates this ITU spectrum policy and disservices the public interest.

The FCC requirement, ostensibly in fulfillment of its ITU obligations, that unlicensed devices must “accept” ISM interference in order to use the ISM bands rings hollow when it is clear that powerful radio interests have no intention of coexisting with ISM and wield sufficient market power to co-opt the ISM bands. Acceptance of interference from ISM is not only a statement of ISM’s legal right to exist but it also means that devices which use these bands on an unlicensed basis must demonstrate a technical ability to coexist with ISM for the benefit of the spectrum-using public.

This rule of international law must be made clear or powerful radio interests will be encouraged to force the market to choose communications over ISM in every band allocated to ISM. If the Commission tilts in this direction, it will be abdicating its spectrum management function to the anarchy of unlicensed radio, and emerging ISM businesses will be unable to attract the talent or the investment capital needed to operate in the very bands set aside globally for their use.

IV. The Part 15 Rules Must Be Amended to Restrict Use of the 2.45 GHz ISM Band By Spread Spectrum Devices.

The various technical analyses presented in this docket uniformly conclude that the conflicts between unlicensed spread spectrum devices and 2.45 GHz RF lighting will be substantial and ubiquitous. To avoid imminent harm to the public, immediate regulatory action is needed; however, due to ITU treaty constraints, the Commission must develop new rules for spread spectrum devices. Accordingly, Fusion urges that the Part 15 rules be

amended to increase the signal rejection capabilities of spread spectrum vis-à-vis RF lighting emissions or, in the alternative, to “migrate” the high power spread spectrum devices out of the 2.45 GHz ISM band and into other less hostile portions of the spectrum.

Increased signal rejection capability can be achieved in various ways. Studies have shown, for example, that the packet error rates (PER) for FHSS devices increase significantly in the presence of microwave oven emissions when the packet size exceeds 100 bits in length. This phenomenon was observed in the Metricom's Microwave Interference Report ("excess in burst errors over 100 bits in length"),⁸⁰ and was examined in detail in the Zyren IEEE White Paper; as follows:

FHSS receivers can transmit short packets (100-200 bytes) even in a very noisy environment. However when using longer packets (1000 bytes), FHSS systems require a signal strength of 16 to 17 dB above peak interference levels to achieve reliable operation in the presence of [microwave oven] interference when operating at 1 Mbps. This effect is even more pronounced when operating at 2 Mbps.⁸¹

FHSS packet size also explains how the Part 15 Interests arrived at their 70 meter minimum separation requirement (albeit from an interference source 100 times less powerful than an RF lamp). In that analysis, the FHSS system was transmitting 500 byte packets at 2 Mbps,⁸² a design which their earlier studies predicted would perform unreliably in the presence of typical ISM interference. An amendment to the Part 15 Rules setting a maximum FHSS packet size of 100 bytes⁸³ could possibly render these devices more immune to RF lighting and restore FHSS to its originally intended role of providing short range, low data rate communications links.⁸⁴

⁸⁰ See fn. 6 *supra*, p. 3.

⁸¹ See fn. 18 *supra*, p. 2.

⁸² See March Proposal, p. 3.

⁸³ See Zyren IEEE White Paper, p. 16. According to this study, both 1 Mbps and 2 Mbps systems can operate reliably with 100 byte packets. As the size increases, however, 2 Mbps system reliability degrades faster than 1 Mbps system reliability.

⁸⁴ When the Part 15 spread spectrum rules were first adopted, the hopping bandwidth was set at 25 kHz specifically to make these devices less susceptible to ISM interference. See Docket 81-413, First Report & Order. Industry pressure led to a forty-fold increase in hopping channel bandwidth for significantly higher data rate applications. As a result these devices are now less immune to ISM interference.

Another means to improve FHSS reliability and ensure high signal rejection capability in the presence of RF lighting would be to require fixed FHSS systems operating above certain technical thresholds (in terms of power, bandwidth or packet size) to be "coordinated" around RF lighting installations or site-shielded to minimize interference to users. Co-located systems like Metricom's, which are intended to occupy the same utility poles as Fusion RF lamps, could be required to implement digital signal processing algorithms that "sense" ISM emissions and alter their transmission protocols to avoid interference. Fusion understands that such spectrum-intelligent technology is currently on the market and has actually been offered as a solution to ISM interference by Clearwire Communications⁸⁵ and others. Fusion requests these matters to be studied in a further rulemaking.

For DSSS technology, study after study has shown that these systems may not suffer from the same type of interference problems as FHSS because they provide "processing gain against narrowband interferences [*sic*] including microwave ovens."⁸⁶ The Zyren IEEE White Paper, for example, shows how the reliability of DSSS is far less dependent on packet size because ISM interference is dealt with by suppressing it, not by avoiding it, allowing this device to "operate reliably in very close proximity of a microwave oven."⁸⁷ These findings are supported by the Lucent Analysis, which calculates DSSS resistance to in-band interference to be "17 dB greater than FHSS."⁸⁸ Because the "separations" studies in this docket focused primarily on FHSS systems, Fusion does not know whether the processing gain requirements for DSSS should be increased to make them less prone to RF lighting emissions. Again, however, this is a matter that should be carefully studied in a further rulemaking.⁸⁹

⁸⁵ See www.clearwire.com.

⁸⁶ Zyren IEEE White Paper Analysis, p. 12.

⁸⁷ *Id.* p. 2, 15, 16.

⁸⁸ See letter of October 15, 1999, to M. Salas from T. Mahn, transmitting the Lucent Technologies study prepared by A. Kamerman and N. Erkocevic, Microwave Oven Interference on Wireless LANs Operating in the 2.4 GHz ISM Band ("Lucent Analysis"), ¶ VII. Data is based on the IEEE 802.11 standard.

⁸⁹ A comparison of test results showed the DSSS systems can operate reliably (< 10% PER) regardless of packet size or transmission speed, whereas FHSS can only operate reliably at 100 byte (or shorter) packet length. See Zyren IEEE White Paper p. 16.

The alternative to technical rule amendments -- migration of ISM susceptible unlicensed spread spectrum devices to other bands -- is perhaps the better option as it would allow for more robust device operations. The 915 MHz ISM band is already used widely for spread spectrum and contains a Part 15 "safe harbor" that no other band enjoys. The 5.8 GHz ISM band would be another prime location for migration as it is internationally harmonized, allocated in the U.S. for spread spectrum use and is currently the focus of NII device⁹⁰ developments. More importantly, there are few if any ISM applications in the band, none are known to be under development, and its greater bandwidth (50 MHz more than the 2.45 GHz band) would allow for increased capacity and flexibility for unlicensed use.⁹¹ While the Part 15 Interests readily admit that the primary reason the 5.8 GHz band has not been seriously considered is due to the higher cost of technology, Fusion submits that this is hardly a compelling reason given that the spectrum is free and unencumbered.

Other candidate bands for unlicensed spread spectrum operation which a further rulemaking should explore are the 24 GHz ISM band and the millimeter wave allocations above 40 GHz, which are themselves in rulemaking.⁹² While these bands may have some limitations, as all bands do, it should be clear to the Commission that the public will not be without numerous alternatives to the wide range of wireless offerings being contemplated by the Part 15 Interests.⁹³

V. The Administrative Procedures Act Requires a Further Notice and Opportunity for Public Comment Before New Regulations Can Be Adopted.

The Public Notice for this Rulemaking never contemplated in-band limits on ISM for the protection of Part 15 devices and it cannot seriously be alleged that such is a "logical outgrowth" of the original proposals. ISM limits were addressed only in the context of band

⁹⁰ See 47 C.F.R. § 15.401.

⁹¹ Industry standards (IEEE 802.11) developed for spread spectrum RLANS at 2.45 GHz should be adaptable to 5.8 GHz use.

⁹² See fn. 40 *supra*.

⁹³ See, e.g., Commission's Fourth Annual Report on the State of Wireless Competition (FCC 99-136), June 10, 1999. By Fusion's count, some 20 different radio services are offering or gearing up to offer wireless Internet access similar to what Metricom is promoting.

sharing with MSS,⁹⁴ a licensed service allocated spectrum above 2483.5 MHz, where Part 15 spread spectrum devices are not authorized. In Omnipoint v. FCC,⁹⁵ the Court of Appeals held that a final rule cannot be a “logical outgrowth” of a proposed rule when the changes are so major that the original notice did not adequately frame the subjects for discussion.”⁹⁶ Here, the question of in-band limits for the protection of MSS focused on an allocation in the ISM band where Part 15 spread spectrum devices are not even authorized to operate. The various *ex parte* discussions, which raised the issue of in-band limits to protect Part 15 for the first time, are insufficient to give interested parties, much less the public at large, a reasonable opportunity to participate in rulemaking on these issues. Any rule changes for the protection of unlicensed device in ISM bands, therefore, would be in derogation of the Administrative Procedures Act.⁹⁷ Similarly, limits on Part 15 were never contemplated in the NPRM, although subsequent *ex parte* evidence presented by the parties suggests this may be the appropriate relief. To provide all interested parties an opportunity to be heard on the interference issues raised herein, a further notice of rulemaking is required by the APA.

CONCLUSION

Based on the foregoing discussion, Fusion requests that the Commission immediately institute a further rulemaking proceeding to resolve the spectrum conflict between RF lighting and unlicensed spread spectrum devices in the 2.45 GHz band.

⁹⁴ NPRM ¶ 13.

⁹⁵ See *Omnipoint Corp. v. FCC*, 2 CR 816, 28 F.3d 620 (D.C. Cir 1996).

⁹⁶ *Id.*, 2 CR at 824-825.

⁹⁷ See also, *In The Matter of Provisions of Aeronautical Services* via the Inmarsat Systems, Order on Reconsideration, 11, FCC Rcd 5330 (1996).

Respectfully submitted

A handwritten signature in black ink, appearing to read 'TGM', with a long horizontal line extending to the right.

Terry G. Mahn, Esq.
Ruffin B. Cordell, Esq.
Fish & Richardson P.C.
601 13th Street, N.W.
Suite 901 South
Washington, DC 20005

Counsel for Fusion Lighting, Inc.

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